CALIBRATION AND RECONSTRUCTION IN THE NOνA DETECTORS

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- The *NOνA* long – baseline neutrino experiment will study ν_e appearance using two high resolution, fully active scintillator detectors.
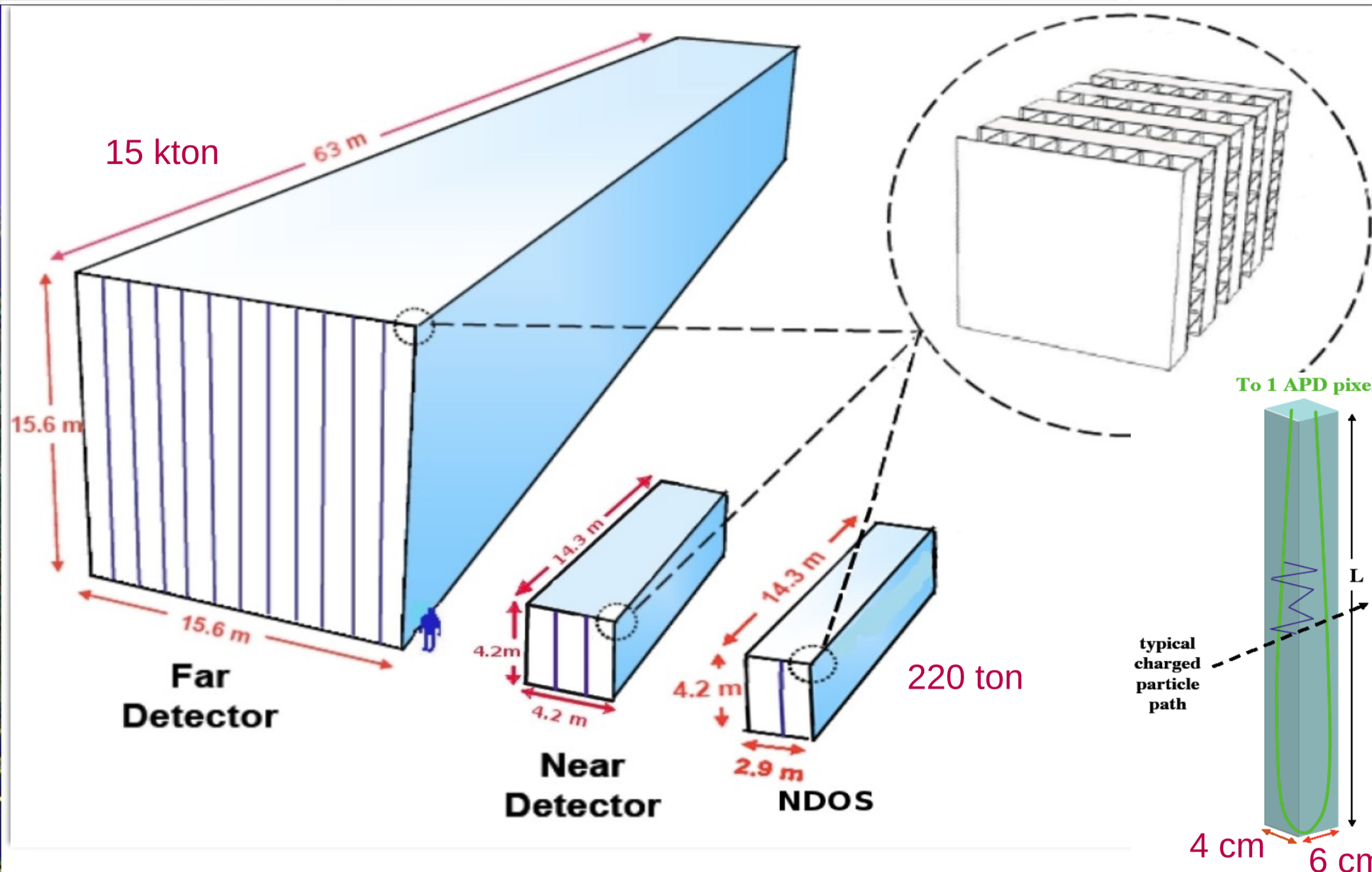
  - *Near Detector* at *Fermilab*.
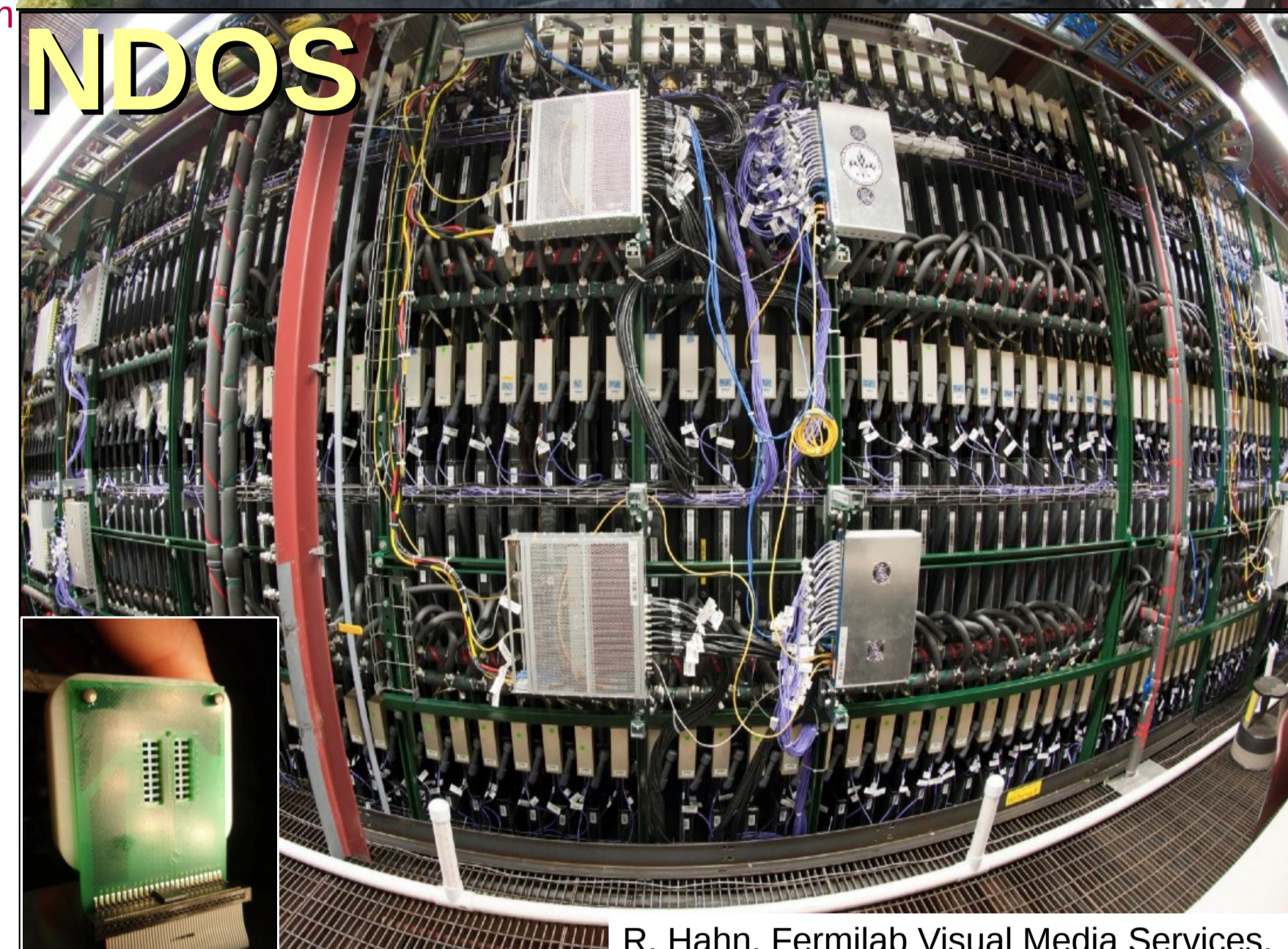
  - *Far Detector* at *Ash River, MN*.

  - The Collaboration built a *Near Detector On the Surface*, *NDOS*, at *Fermilab*, to use as a prototype to test, e.g. electronic components and *DAQ* firmware.
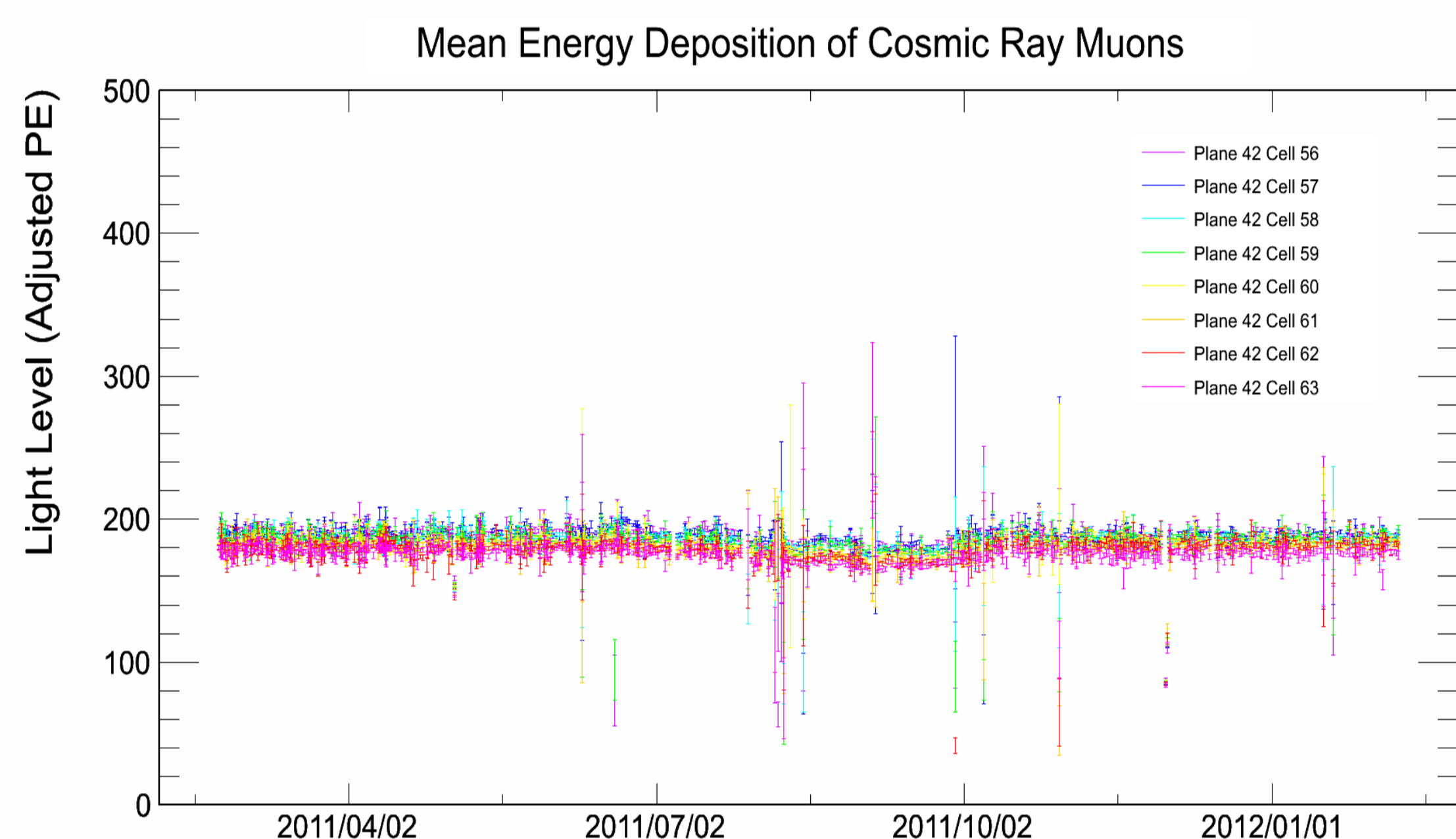
  - 6° off the *NuMI Beam* axis.

  - On the *Booster Beam* axis.

The experiment has more than 155 collaborators from 25 institutions.

- The detectors are made out of *PVC Modules*.
- They are filled with *Liquid Scintillator*.
- The *Modules* are layered planes of orthogonal views.
- The *Planes* are divided into *Cells*, and each *Cell* has a *Wavelength Shifting Fiber* to collect light.
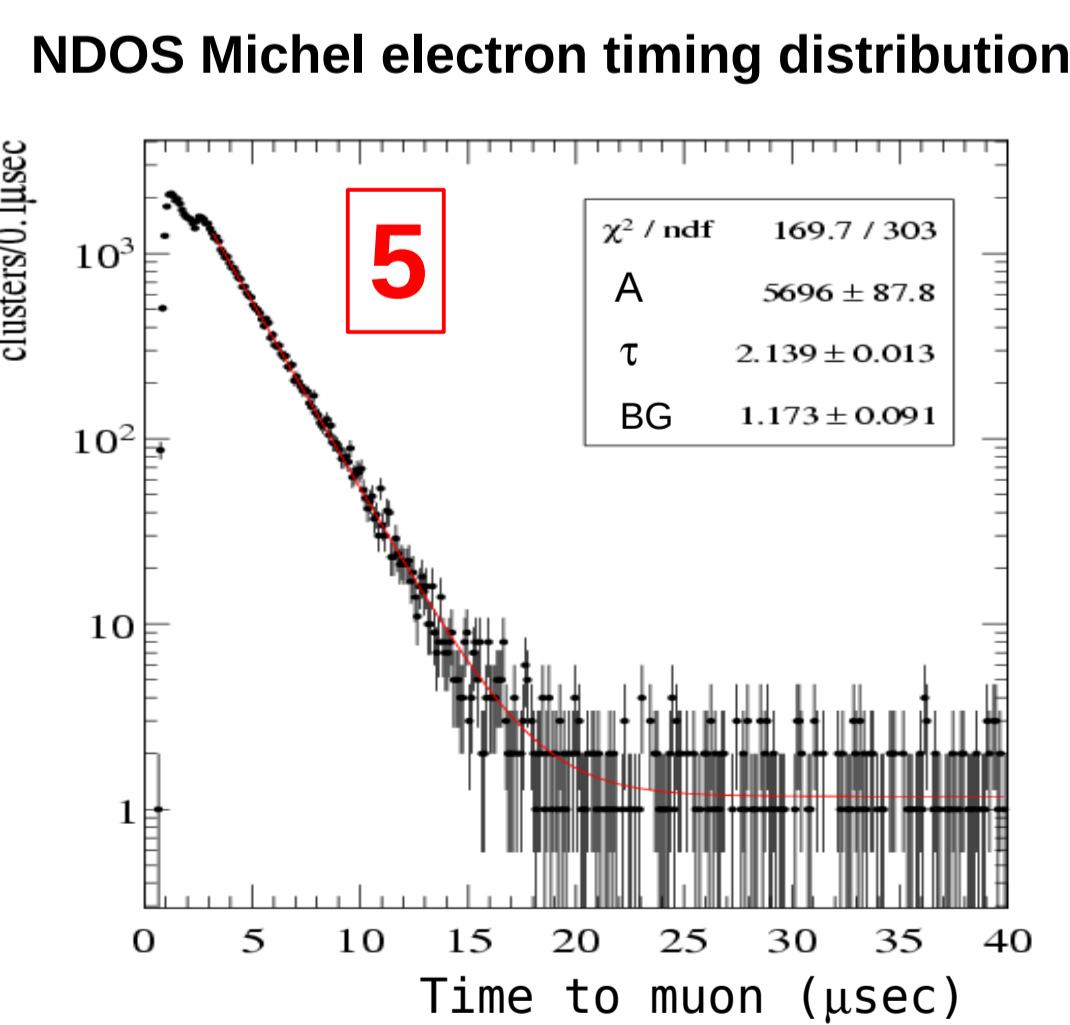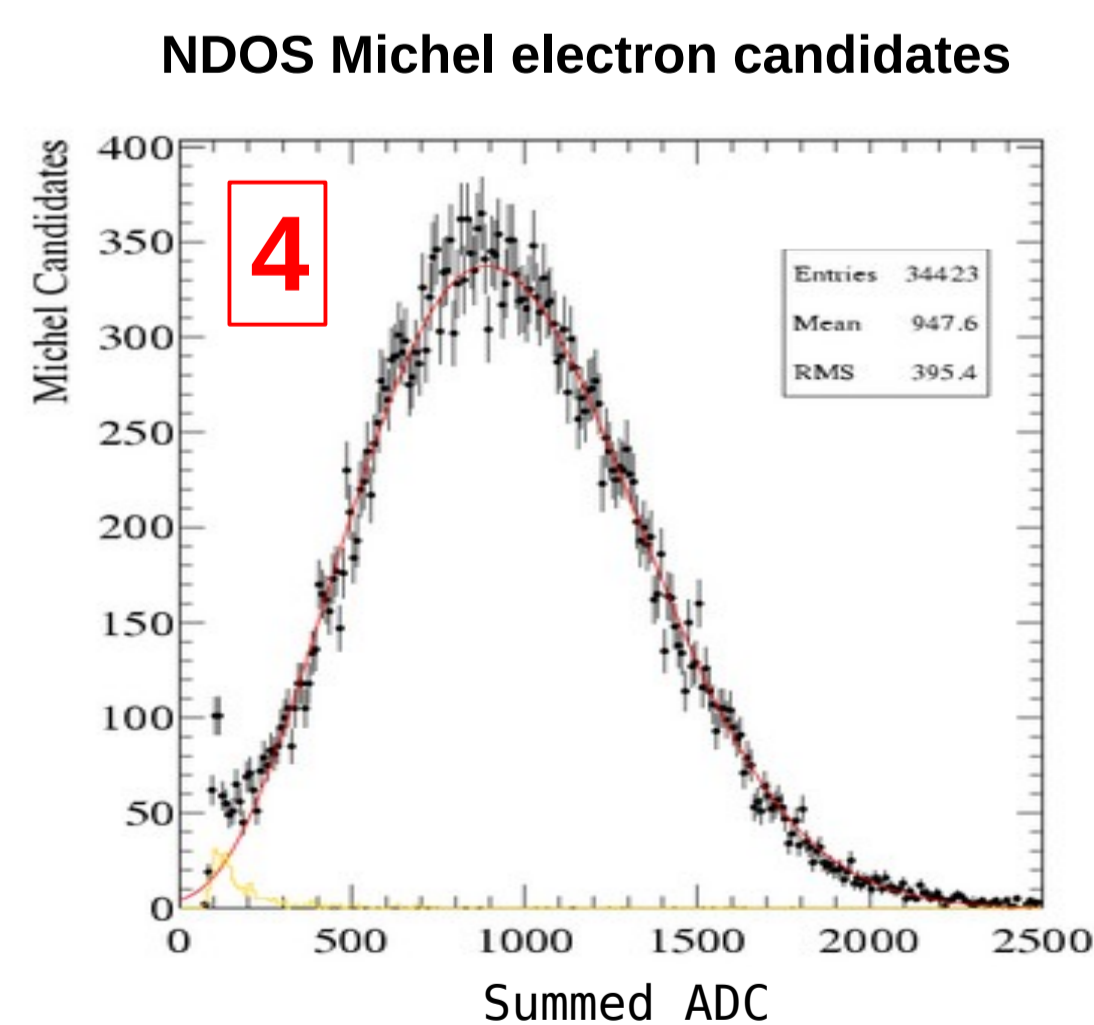- The light is detected by *Avalanche Photo Diodes*.

NDOS

R. Hahn, Fermilab Visual Media Services.

Mean Energy Deposition of Cosmic Ray Muons

Plane 42 Cell 56
Plane 42 Cell 57
Plane 42 Cell 58
Plane 42 Cell 59
Plane 42 Cell 60
Plane 42 Cell 61
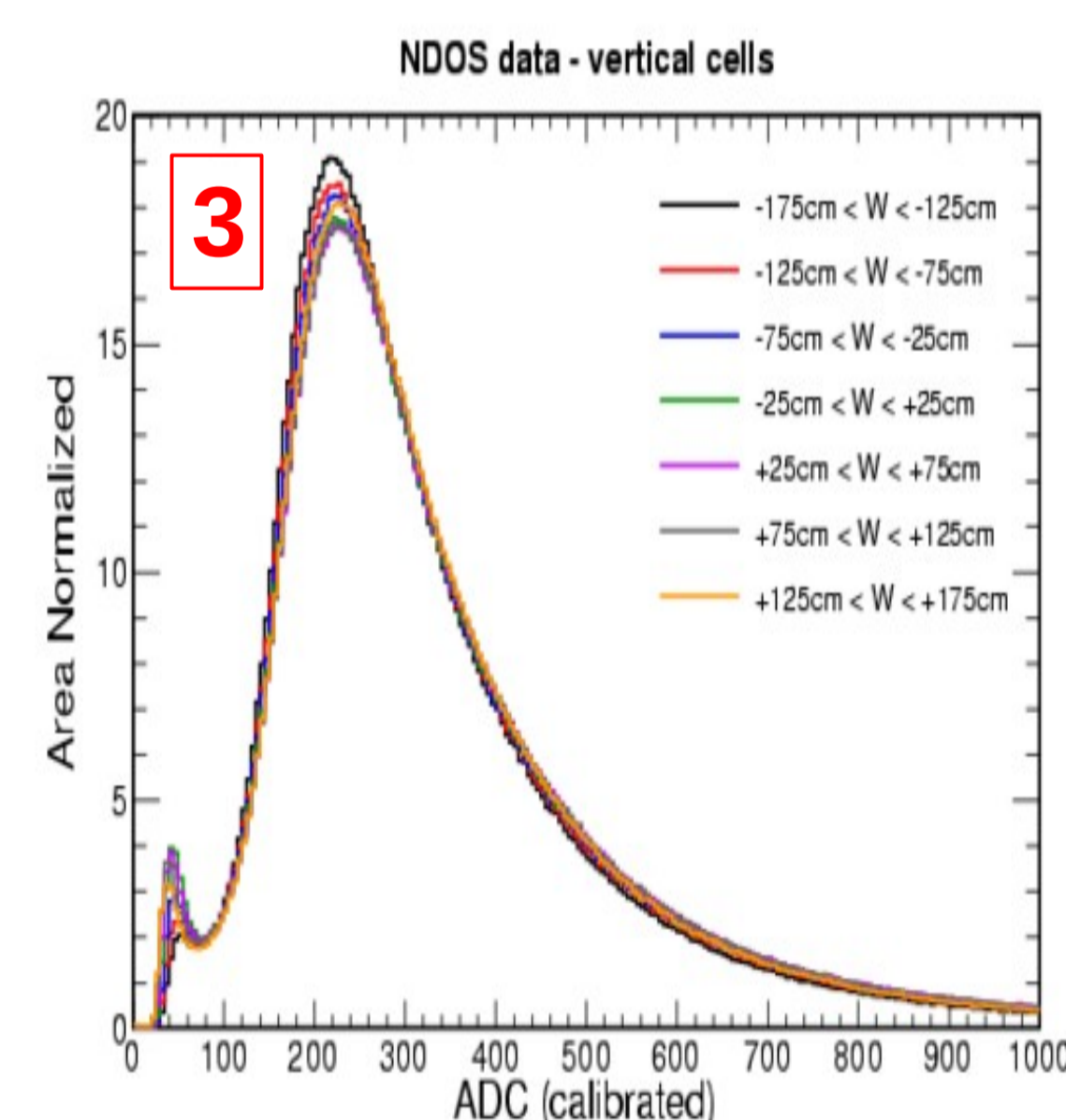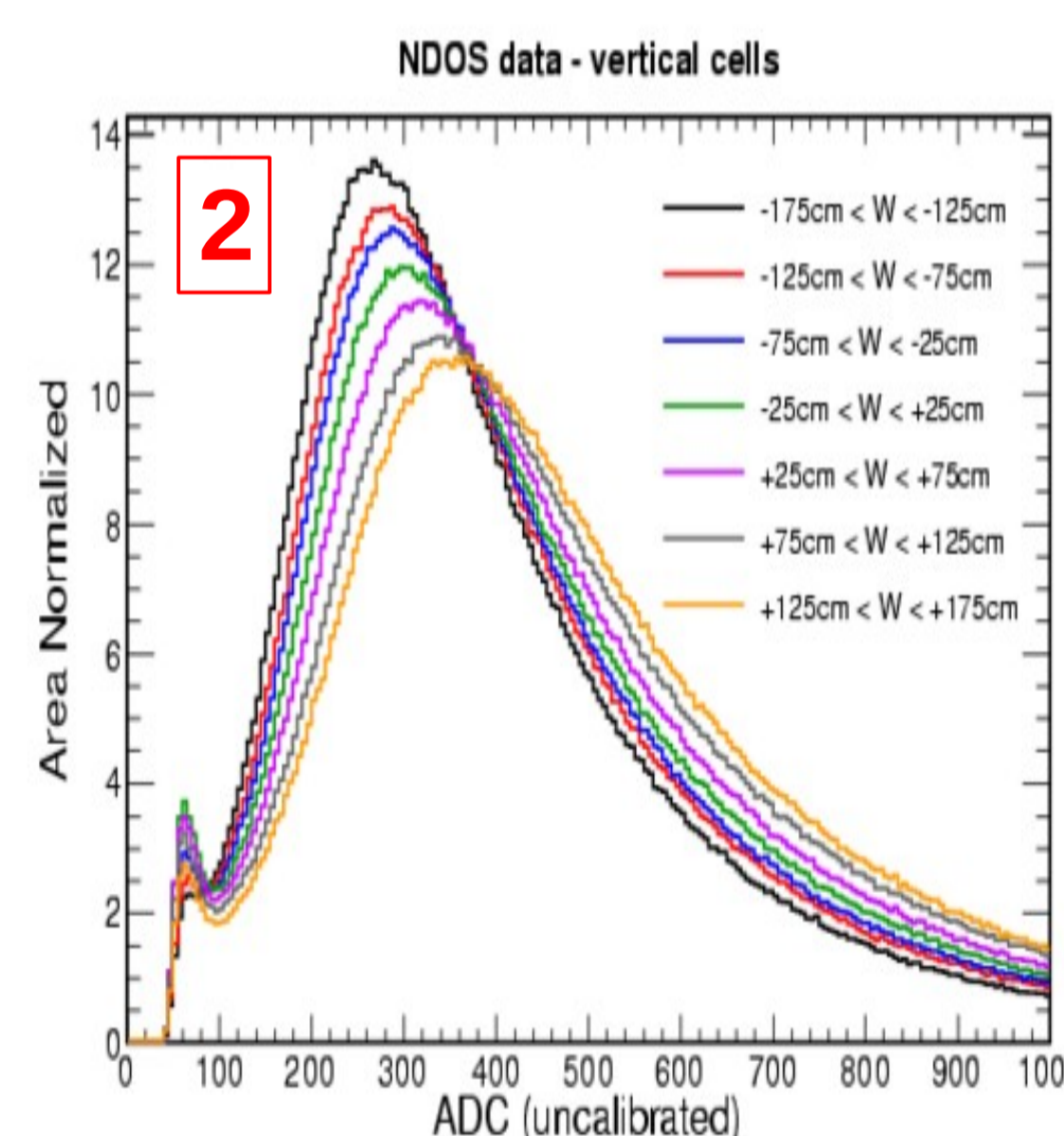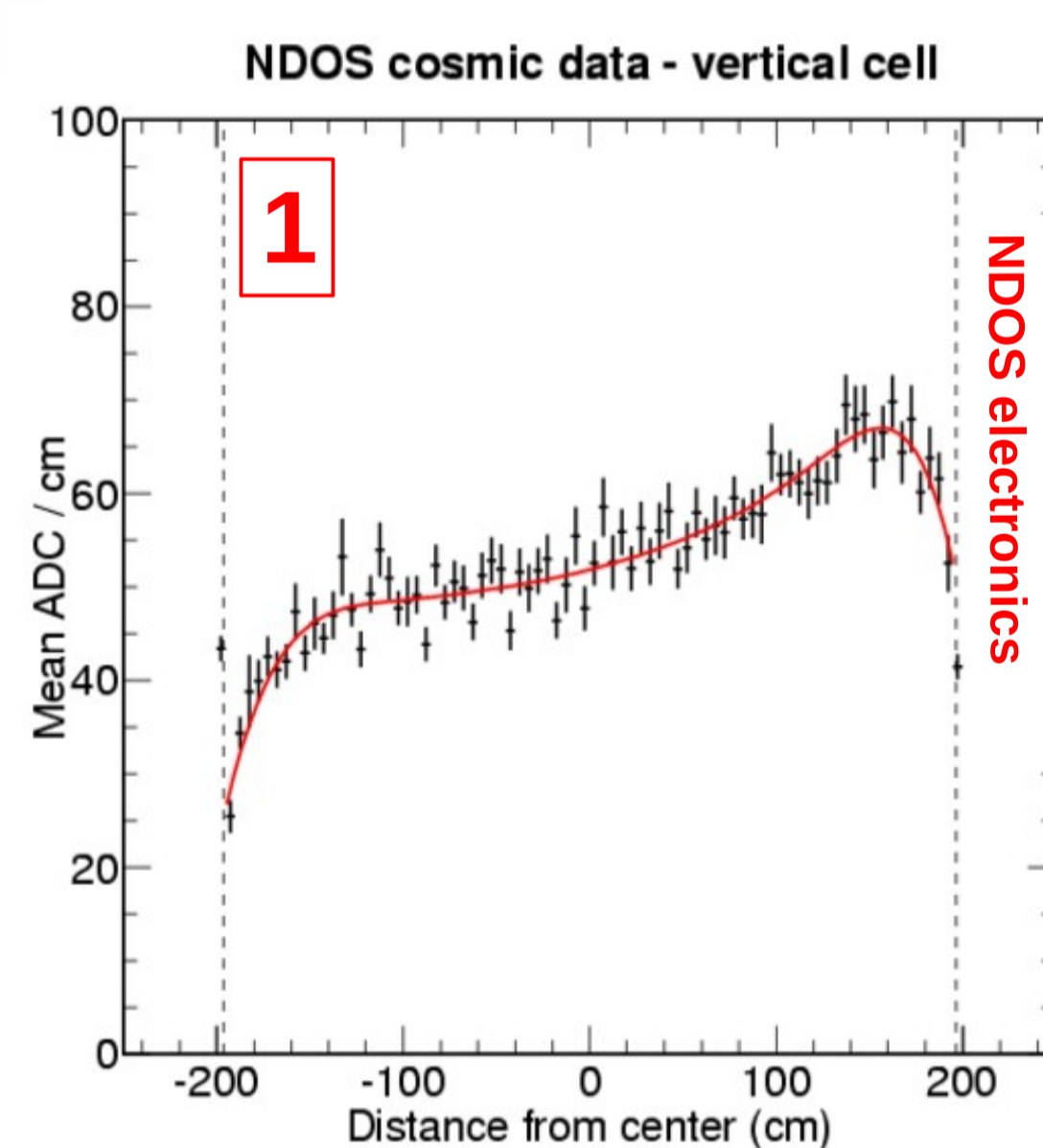Plane 42 Cell 62
Plane 42 Cell 63

- The *NDOS* measures the *Charge* (*ADC*) deposition per *Cell*, and from it the calibration process finds scaling factors to reconstruct the true energy deposited.

- The approximate number of *PhotoElectrons*, *PE*, in a *Cell* per event is a rescaling of the charge at the peak of the *ADC* distribution.

- To account for the differences in light yield due to the distance, *W*, of a hit in a *Cell* to its *APD*: the *PE* are scaled to *PECorr* such that $PECorr_i = PECorr_j$ means that the true energy depositions E_i and E_j are the same regardless of the W_i and W_j.

1. Mean *ADC / cm* vs. distance, *W*. The **fit** is used to account for the variations in the light yield as a function of *W*.

2. *ADC* distributions for various *W* slices before the attenuation corrections.

3. *ADC* distributions for various *W* slices after the attenuation corrections.

NDOS cosmic data - vertical cell | NDOS data - vertical cells | NDOS data - vertical cells

-175cm < W < -125cm
-125cm < W < -75cm
-75cm < W < -25cm
-25cm < W < +25cm
+25cm < W < +75cm
+75cm < W < +125cm
+125cm < W < +175cm

NDOS Michel electron candidates | NDOS Michel electron timing distribution

- Stopping *muons* are a good sample to calibrate absolute energy since the energy deposited in the last portion of their path is known.

- The reconstructed *track – length* is used in the calibration process, along with the charge deposition, to calculate scale factors, using the *Minimum Ionizing Particle* and *Bethe – Bloch* concepts, which allow to get true energy.

- *Michel electrons* studies would provide a scale factor to convert *PECorr* to true energy since their energy distribution is well – known.

4. The *Michel electron* candidates are required to be within 30 *cm* of the muon end point, and between 3 – 10 μ*sec* of the muon.

5. $A(t) = Ae^{-t/\tau} + BG$. The timing distribution agrees with the expected value, τ_c = 2.123 *μsec*, from cosmic μ^- and μ^+, and shows low background, *BG*.

Charge Current Deep Inelastic candidate

Michel electron candidate